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UNIONIZATION AND REGULATION
THE DIVISION OF RENTS IN THE TRUCKING INDUSTRY

Nancy L. Rose

May 1985
Revised: July 1985

MIT Sloan School of Management Working Paper: #1684-85

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This paper examines the division of regulatory rents in the trucking industry between the owners of trucking firms and members of the Teamsters Union. Previous studies of the effects of the Teamsters Union on the trucking industry--most notably Annable (1973), Moore (1978), and Hayden (1977)--have focused on wage trends or union/nonunion wage differentials. These analyses rely primarily upon aggregate data, usually at the industry level, although Hayden and Moore also use some wage data for a individual truck drivers. The findings of these studies are difficult to interpret. Aggregate wage trends tell us little, particularly in the absence of controls for productivity change, industry growth, and overall economic activity. Estimates of union/nonunion wage differentials may help to quantify the magnitude of the union's effect on wages, but they do not reveal the split of rents between the union and trucking companies. Differences in non-wage compensation and productivity levels as well as possible employment-wage trade-offs all tend to alter the implications of a given union wage differential for rent-sharing. Although my work in the previous chapter attempts to circumvent these problems by estimating the response of union premia to regulatory reform, that analysis can provide only a lower bound on rents captured by the union. These shortcomings suggest the desirability of an alternative approach.

A potential solution is to estimate the impact of unionization directly from trucking companies' profits. Because most firms were unionized early in the industry's history, data are not available to estimate these effects from a time series of profits before and after

unionization. Rather, profitability effects must be identified from cross-sectional variation in unionization rates and profits across firms. I choose to estimate union profit shares from data on marketbased measures of firm value. I construct a measure of the excess of the firm's market value over its replacement cost, divided by total sales (referred to as EMVS). This can be thought of as a market-based relative of the profit-to-sales ratio. The presence of monopoly rents will cause EMVS to exceed zero by an amount reflecting the present value of future monopoly profits.[1] If the union shares in these profits, the differential in EMVS between union and nonunion firms should reflect the rents captured by the union. This permits direct estimation of union rent-sharing. Salinger (1984) uses a similar approach, based on Tobin's q, to estimate an average union share of 77 percent of profits for firms in a cross-section of manufacturing industries.

The empirical results of this study suggest that the Teamsters Union has been a powerful force in the trucking industry. Estimates of the union's share of profits average about seventy percent of total rents. These translate into fifty to sixty thousand dollars of rent per worker in present discounted value. Assuming a ten percent discount rate, the union's annual rents per worker are five to six thousand dollars.

The remainder of the paper proceeds as follows: Section I outlines the methodology, and section II describes the data. Estimation techniques are discussed in Section III, and results for several variants of the model are presented.

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[1]This is of course a simplification. Disequilibrium rents and rents on scarce factors of production may also cause EMVS to be greater than zero. Because of the close link between EMVS and Tobin's q (q will

I. Methodology

The cleanest test for union rent-sharing would be to observe the market value of trucking firms before and after unionization. Unfortunately, data on share prices of motor carriers around the time of their unionization generally are not available. The bulk of the Teamsters' organization of the trucking industry took place in the late 1930s and early 1940s; by 1946 the Department of Labor classified trucking in its group of industries that were 80 to 100 percent unionized.[2] During this period, most firms were small, privately held companies; even the larger trucking companies tended not to be widely traded. In addition, records of when a particular firm was unionized typically are not available. As a consequence, the union's share of profits must be estimated from variations in unionization rates of already organized firms.

This study uses cross-sectional variation in unionization rates to identify the effect of unions on profitability. (Although time-series variation could in principle be used to estimate λ, unionization rates for a given firm are virtually constant over the period studied.) If the Teamsters capture a share of rents, firms with a larger fraction of unionized labor will have lower profits, other things equal. Most of the

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be one under the conditions that yield an EMVS of zero), the literature on q is relevant here. See Lindenberg and Ross (1981) for a description of the implications of q in industrial organization models. Taxes also may lead to a divergence of market value and replacement cost of capital. See Salinger and Summers (1983).

[2]U.S. Department of Labor, "The Extent of Collective Bargaining and Union Recognition in 1945," Monthly Labor Review, April 1946, pp. 567-572.

important methodological problems arise from attempting to ensure that "other things" are equal, and in particular, from accounting for variations in the total value of monopoly rents.

In principle, the union's share of rents can be estimated from either annual accounting profit data or asset market value data. I choose to use the latter. This avoids many of the potential measurement error biases associated with accounting data, as discussed in Salinger (1984).[3] Use of such measures also yields estimates of a long-run union effect, reducing noise associated with short-run or cyclical effects of unionization on profitability. The value of the firm is the present discounted value of its cash flows over time. In long-run equilibrium with no taxes,[4] this is given by:

$$(1) \qquad V_t = \int_t^\infty [(P_s - AC_s)F(K_s,L_s) + rK_s - \dot{K}_s]e^{-r(s-t)}ds$$

where V_t = value of firm at time t

P_s = price of output at time s

AC_s = average cost of output at time s

$F(\cdot)$ = output

K_s = capital stock at time s

L_s = labor at time s

r = discount rate

and $\dot{K}_s$ = change in capital stock at time s (net investment)

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[3]See also Fisher (1984, 1985) and Scherer (1980) for a discussion of accounting data measurement problems.

[4]In theory, adjustments can be make to this basic model to account for dividend and corporate income taxes. Salinger and Summers (1983) discuss one way to treat these in valuing the firm and its capital

Assuming a constant discount rate r and steady-state growth at rate g, this can be re-written:[5]

$$(2) \qquad V_t = K_t + \Pi_t$$

where Π_t is the present discounted value of rents, equal to $(P_t - AC_t) \cdot F(K_t, L_t)/(r-g)$. I consider two specifications of the union-profit interaction. The first assumes that the union takes a constant share, λ, of profits. This model, referred to as a "constant profit share" contract or specification A, expresses firm value as

$$(3) \qquad V_t^A = K_t + \Pi_t \cdot (1 - \lambda u)$$

where u is the proportion of the firm's labor force that belongs to the union and λ is the share of rents the union captures from an all-union firm. The second specification assumes that the union takes a constant level of profits, γ, per unionized worker. This model, referred to as a "constant wage premium" contract or specification B, expresses firm value as

$$(4) \qquad V_t^B = K_t + \Pi_t - \gamma \cdot u \cdot L$$

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stock. In practice, however, these adjustments are relatively uncertain or controversial. Salinger (1983) chooses not to make them in his study of the determinants of profitability which uses Tobin's q (V/K) as the dependent variable. Lindenberg and Ross similarly ignore taxes in their treatment of q. I follow this tradition, and omit taxes from my analysis.

5. Where capital grows at rate g, $\dot{K}/K = g$.

where γ is the union's present discounted value of rents per worker, and L is the number of workers in the firm.

Equations 3 and 4 express firm value as a function of the level of monopoly rents and firm unionization rates. In general, the level of rents will depend on the scale of the firm's operations. Firms that are in some sense larger should have larger profits, holding all else constant. I therefore normalize these equations so that the resulting profit rate is the same across companies, conditional on other characteristics. Two scaling factors suggest themselves. One possibility is to divide the firm's market value by the replacement cost of its capital stock. This yields Tobin's q (V/K) as the dependent variable. This will be appropriate if rents are proportional to the amount of capital employed by the firm. An alternative is to scale the market value by sales (total revenues). Specifically, I define the ratio of excess market value to sales (EMVS) as market value minus the replacement cost of capital, divided by sales. This measure is similar in concept to the profit-to-sales ratios used in much of the profitability/concentration literature.[6] EMVS is an appropriate measure of profitability when profits are proportional to total revenues; that is, when rents are a mark-up over total costs.

I choose to use EMVS in the results I report below. I also have estimated equations using q as the dependent variable, with modifications to account for the different scaling factor. Although these yield quite similar results, the results using q are much less stable than are the EMVS

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[6]Because EMVS is based on market value rather than on one-period accounting profits, it avoids many of the masurement problems associated with profit-to-sales ratios.

results, and are sensitive to even minor changes in specification. This performance is not entirely surprising, as the use of q as the dependent variable necessitates a number of assumptions and adjustments that are not required for the EMVS equations.[7] Because of this, reporting only the EMVS results seems most appropriate. This implies transforming (3) and (4) as:

$$(3') \qquad EMVS_t^A = \frac{V_t - K_t}{Sales_t} = \frac{\Pi_t}{Sales_t} \cdot (1 - \lambda u)$$

and

$$(4') \qquad EMVS_t^B = \frac{V_t - K_t}{Sales_t} = \frac{\Pi_t}{Sales_t} - \frac{\gamma \cdot u \cdot L}{Sales_t}$$

These relations are the basis of the equations to be estimated in the results section. However, a number of adjustments are required to implement these specifications. These are highlighted below.

The first step is to characterize the determinants of what I will refer to as the "profit rate", $\tilde{\pi}$, defined as the ratio of the present discounted value of rents to total revenues, Π/sales. I consider two models of "profitability." The first defines the profit rate as a linear function of three characteristics of the firm's trucking operations: the proportion of the company's business that is in less-than-truckload operations (denoted LTLPER); the size of the firm's operations, measured in ton-miles of goods transported (TONMILE); and the average size of loads in tons (AVLOAD). This model of $\tilde{\pi}$ is:

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[7]For example, many trucking firms employ substantial amounts of rented or leased capital. The replacement cost of capital owned by these firms will understate the stock of capital employed by the firm, causing q to overstate the "profitability" rate. Accounting for this requires including the value of rented or leased capital in the

$$(5) \qquad \tilde{\pi} = \phi_0 + \phi_1.\text{LTLPER} + \phi_2.\text{TONMILE} + \phi_3.\text{AVLOAD}$$

All three factors should be positively associated with profitability. First, less-than-truckload (LTL) traffic was more effectively protected by regulation than was truckload freight, as a result of tighter entry control, more effective rate collusion, and fewer opportunities for substitution away from regulated carriers in LTL markets.[8] This suggests that the larger is the proportion of a firm's business in LTL shipments (LTLPER), the higher its profit rate. Second, firm size, as measured by ton-miles of shipments, should increase profits. This variable will pick up the effects of any economies of scale or of scope, as well as demand side considerations that reward larger firms.[9] Finally, average load size and profitability should move together. This will result from non-price competition, which will tend to reduce both profits and average load as firms compete by offering more frequent or faster service. AVLOAD may also capture the effects of more efficient route structures: firms with more efficient route configurations or regulatory authority for clusters of local markets can consolidate freight and realize larger average line-hauls

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calculation of total capital. However, data on rental and leases--let alone the capital value of such leases-- is typically quite poor. Similarly, to account for non-trucking subsidiaries (discussed further below), the share of motor carrier capital in total replacement cost of capital must be determined for the q equations. The only data available on capital by lines of business is based on net book assets. Theis is likely to be much less accurate than the corresponding adjustment for EMVS, which is based on the share of revenues (for which accounting data is typically quite accurate).

[8]See Moore (1983a) and Rose (1984).

[9]Shippers prefer to minimize both the number of trucking firms they tender freight to and the number of interlining movements required to deliver freight to each destination; see, e.g., LaMond (1980), pp. 75-77. While these preferences reward companies with extensive route

than can firms with more restricted route authorities.

Of course, this parameterization of profitability is over-simplified, but this is unavoidable. Data are unavailable for many firm characteristics, particularly those relating to network structure. In addition, the small sample size used in this study precludes a very large model; with parameters essentially identified by a cross-section of 21 firms, the dimension of the parameter vector must be restricted.

As an alternative, I also model profitability as a function of the expected rent loss due to deregulation. In an earlier paper (Rose, 1984), I calculated the losses in firm value resulting from ICC "deregulation" of the trucking industry during the late 1970s. These losses are estimated from share price responses to announcements of regulatory reforms, and reflect the expected change in firm value resulting from the reform announcements. Although there are a number of reasons why this measure may differ from the present value of regulatory rents,[10] the estimates may provide a reasonable proxy for rents. The second model of total profits is therefore:

$$(6) \qquad \tilde{\pi} = \beta \cdot LOSS/Sales$$

where β is a scale parameter, assumed constant across firms, and LOSS is the change in expected value of the firm, as calculated in my earlier work.

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structures (that is, firms with authority to serve a wide range of geographic markets) rather than large firms, _per se_, firm size may proxy for unavailable data on network size.

[10]These losses measure the expected change in the present value of the firm as a result of deregulation. As such, they are estimates of the rents accruing to the firm under regulation. However, they may differ from Π for a number of reasons. First, they are the expected effect of particular deregulatory policies. LOSS may understate Π if

Equations using this model of profitability are estimated by instrumental variables, to treat the measurement error in LOSS as a proxy for Π. The three characteristics discussed above--LTLPER, TONMILE, and AVLOAD--are used as instruments for LOSS.

A second adjustment is required to account for conglomerates; that is, firms that own both trucking and non-trucking subsidiaries. Because the models of profitability described above explain only rents arising from trucking operations, an adjustment for non-trucking operations is required. Let the value of a conglomerate be $V_C = V_m + V_{nm}$, where m denotes motor carrier operations and nm denotes all other businesses in which the firm is engaged. We can re-write equation (3') as:

$$(7) \qquad EMVS_C^A = \frac{V_C - K_C}{Sales_C} = \frac{Sales_{nm}}{Sales_C} \cdot \frac{\Pi_{nm}}{Sales_{nm}} + \frac{Sales_m}{Sales_C} \cdot \frac{\Pi_m \cdot (1 - \lambda u)}{Sales_m}$$

where Π_{nm} is the present value of rents earned by the non-trucking portion of the firm's business. A similar transformation can be made for (4').

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some reforms that reduced value were omitted from the analysis, or if reforms reduced but did not eliminate regulatory protection. Second, LOSS represents the net loss to the firm. To the extent that deregulation either imposed adjustment costs on firms or created new profit opportunities, LOSS will deviate from regulatory rents. Finally, LOSS may be net of the union share. That is, if union's share in profits and adjust wages up and down freely, then the loss to the firm as a result of deregulation should be $\Pi \cdot (1-\lambda u)$. This depends on critically on the expected union response to deregulation. If the union retains a constant fixed amount, as in contract B, then firm value may decline by close to the entire value of rents. The evidence in Rose (1984) supports the view that the union was not expected to adjust shares freely, as more unionized firms lost a higher proportion of value as a result of deregulation. It should also be noted that under the null hypothesis of no union rent-sharing, LOSS will be an estimate of Π. Although LOSS is an imperfect measure of total rents, it may provide a reasonable proxy.

It is infeasible to model the determinants of the profit rates of non-trucking businesses, which range from pipe fittings to furniture manufacturing to food product distribution. I therefore estimate a separate constant for non-trucking operations, which measures the average profit rate of these subsidiaries. If non-trucking operations earn only a competitive rate of return, this constant will be zero. Although this is an imperfect correction, as long as the profitability of trucking operations is uncorrelated with the deviation from mean of other subsidiaries' profitability, the estimate of the union rent share should not be biased. This procedure implies estimating an equation of the form:

$$(8) \quad EMVS_C^A = \alpha 1 \cdot \left(1 - \frac{Sales_m}{Sales_C}\right) + \frac{Sales_m}{Sales_C} \cdot \bar{\pi} \cdot (1 - \lambda u)$$

where $\alpha 1$ is the mean non-motor carrier profitability rate. A corresponding transformation applies to the constant wage premium model.

A final adjustment is made to control for potential endogeneity in unionization rates. A union deciding which companies to organize will trade off the benefits of organization with the costs of organizing the workers. Benefits will tend to be higher if companies are more profitable (if, in fact, unions can capture a share of profits) and if there are barriers to entry of nonunion companies. The costs of organizing may be a function of factors such as worker characteristics, region, average unionization rates in the industry, and management resistance. This trade-off suggests that, other things equal, unions may organize more profitable companies (or organize these companies first), creating

potential endogeneity in the profit/unionization equation.[11] Failing to account for this may bias the estimated union share toward zero. For example, if unions organize high profit firms and take a large share of profits, then firms may appear to have roughly constant profit rates independent of unionization, despite the fact that unions are capturing a large share of rents.

The significance of this distortion is open to question. Clark (1984) argues that it is unlikely to bias results in models such as these. The arguments against this bias are perhaps even more convincing with respect to the trucking industry. First, in trucking any potential endogeneity is unlikely to be firm-specific. Organization of motor carriers seems to have proceeded along industry sector and regional bases. That is, the Teamsters historically organized large blocks of firms at once, essentially acting on all firms within a particular region or type of business.[12] This was accomplished in large part through extensive use of "secondary boycotts," in which unionized firms refused to interline with, accept freight from, deliver freight to, or otherwise deal with nonunion firms the Teamsters were trying to organize.[13] Thus, a local Teamster "monopoly" in San Francisco was able to organize virtually all firms hauling freight

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[11]This suggests that the union's demand for organization may rise with profitability. However, so too may the cost, if more profitable firms are better able to resist organization attempts. These potential effects weaken the argument for endogeneity.

[12]See Garnel (1972), and James and James (1965) for a discussion of early Teamster history.

[13]Secondary boycotts are now illegal, and it appears that the inability to use this tactic has damaged the union's ability to organize new firms. See Levinson (1980), pp. 135-136.

over-the-road to points around San Francisco; the union then used these over-the-road companies to organize other firms they interlined with; these were used to organize local cartage in Los Angeles; and so on.[14] It therefore seems that, to a first approximation at least, firm-specific characteristics were not critical in the organization decision and execution. Rather, regional and industry sector characteristics, such as average profitability, market structure, and the like, determined unionization.[15] If profits are a determinant of unionization, the relevant measure is sector profits, not firm-specific profits.

Second, because organization of the industry took place long before the sample period covered by this study, even sector-specific endogeneity will not be a problem unless there is some persistence in a sector-specific component of the firm's profitability error term. This would require persistence in the error component from the 1940s through to the 1970s, to have an effect on my results. Nevertheless, if the current profit rate does contain such a persistent sector-specific effect, then the error term in the EMVS equations will be correlated with the unionization rate.

This endogeneity can be avoided by conditioning on the sectorspecific effect; that is, by estimating the equation including a fixed effect for each industry sector. To implement this, I separate the sample into the two major industry groups: general freight carriers, which are primarily less-than-truckload (LTL) firms, and specialized commodity carriers, which

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[14]Garnel (1972).

[15]This is an approximation. There are "holdout" firms that are not unionized, including one company in the sample, Overnite Transportation. These are, however, the exception, at least during the regulatory period.

are only truckload carriers. I estimate equations allowing a separate level of profitability for the LTL firms, as a control for possible sector endogeneity. This involves adding the term $\theta \cdot$LTLDUM to the parameterization of $\bar{\pi}$, where θ is the specific effect for the LTL sector and LTLDUM is an indicator variable for this sector.

These adjustments yield four basic equations, combining the choices of the two contract specifications--constant profit share and constant wage premium--and the choices of two specifications of profitability--parameterizing $\bar{\pi}$ by operating characteristics or using deregulation losses as a proxy for rents. Although the model of EMVS imlies that the intercept in these equations should be zero, I include a parameter, $\alpha 0$, to measure the intercept for motor carrier operations. Taxes, errors in the construction of EMVS, and similar factors may cause this estimated parameter to be non-zero. The equations are summarized in Table 1. Note that in the constant wage premium model the parameters $\alpha 0$ and $\phi 0$ cannot be separately identified. In these equations the profit parameterization omits the constant $\phi 0$. The estimated $\hat{\alpha 0}$ will therefore include $\phi 0$.

TABLE 1

SUMMARY OF EQUATIONS

PROFIT SPECIFICATION	CONSTANT PROFIT SHARE CONTRACT	CONSTANT WAGE PREMIUM CONTRACT
$\tilde{\pi} = X\Phi$	$EMVS = \alpha 0 \cdot Prosale + \alpha 1 \cdot (1-Prosale) + Prosale \cdot (1-\lambda u) \cdot (\phi 0 + \phi 1 \cdot LTLPER + \phi 2 \cdot TONMILE + \phi 3 \cdot AVLOAD + \theta \cdot LTLDUM)$	$EMVS = \alpha 0 \cdot Prosale + \alpha 1 \cdot (1-Prosale) + Prosale \cdot (\phi 1 \cdot LTLPER + \phi 2 \cdot TONMILE + \phi 3 \cdot AVLOAD + \theta \cdot LTLDUM - \gamma uL/MCSales)$
$\tilde{\pi} = \frac{\beta \cdot LOSS}{MCSales}$	$EMVS = \alpha 0 \cdot Prosale + \alpha 1 \cdot (1-Prosale) + Prosale \cdot (1-\lambda u) \cdot (\beta \cdot LOSS/MCSales + \theta \cdot LTLDUM)$	$EMVS = \alpha 0 \cdot Prosale + \alpha 1 \cdot (1-Prosale) + Prosale(\beta \cdot LOSS/MCSales + \theta LTLDUM - \gamma uL/MCSales)$

Prosale = $\frac{\text{Motor carrier revenues}}{\text{Total Revenues}}$

LTLPER = percent of revenues from LTL freight

LOSS = proxy for regulatory rents

MCSales = Motor carrier revenues

u = unionization rate

TONMILE = total ton-miles of freight

AVLOAD = average load size in tons

LTLDUM = dummy variable for LTL firms

L = number of employees (Labor)

II. Data

The data set used in this study consists of observations on 21 publicly traded, regulated trucking companies over the period 1973 through 1982. Financial data are from Standard & Poor's COMPUSTAT data base, supplemented by companies' annual 10K filings with the SEC. Operating data on motor carrier operations are from TRINCS Blue Book of the Trucking Industry (various years). The variables used in the analysis are described briefly below. Their derivations are discussed in detail in the data appendix.

1. Financial Variables

The calculation of EMVS requires a measure of both the market value and the replacement cost of capital for each firm. Because accounting data do not reflect economic values or costs, both market value and replacement cost must be constructed from adjustments to book data. My calculations follow the procedures used in earlier studies employing Tobin's q; see especially Brainard, Shoven, and Weiss (1980), Lindenberg and Ross (1981), and Salinger and Summers (1983).

Market value (V) is computed as the sum of the values of four types of claims on the firm: common equity, preferred stock, short-term debt, and long-term debt. The value of the first three claims can readily be determined from reported accounting data. Common equity is valued at market price times number of shares outstanding. Preferred stock is valued as preferred dividends divided by Standard & Poor's preferred stock yield.

Short-term debt is valued at reported book value. However, valuing long-term debt requires a more complicated calculation, as market value is likely to differ substantially from historical book value. This involves constructing a maturity structure for the firm's debt, valuing outstanding debt from each vintage according to the coupon bond formula, and summing across vintages to determine the market value of all long-term debt for each sample year.

The reported holdings of cash and other short-term investments are subtracted from market value, to yield market value net of cash.

Replacement cost (K) is calculated as the sum of the replacement costs of property, plant, and equipment (unfortunately, my data aggregate all three into a single reported item), cash and other short-term investments, and inventories. The plant and equipment series is built up from an investment series for the firm, an estimated rate of economic depreciation, a price deflator for capital investments, and adjustments for mergers and divestitures. The replacement cost of cash and short-term investments is calculated as the book value, since these are short-term assets. The replacement cost of inventories is assumed to be the book value, except when inventories are valued by LIFO (last-in, first-out) methods. In this latter case, accounting inventories are adjusted to reflect changing prices, using an inventory price deflator.

These yield EMVS = (V - K)/Sales, where Sales are total revenues reported by COMPUSTAT.

2. Operating Characteristics

Data on firm's operating characteristics are from TRINCS Blue Book, except where noted otherwise. Because firm operating characteristics change very little over time, these data are collected biannually. For firms with more than one trucking subsidiary, operating characteristics are computed as the sum of reported values for individual subsidiaries.

Unionization rates (u) are defined as (1-RENT), where RENT is the proportion of total miles accounted for by vehicles rented with drivers. These drivers typically are owner-operators; because data on firm level unionization rates are not available, I use this measure to represent the potential share of union labor. Note that this calculation assumes that employee drivers are all unionized, and that all owner-operators are not. For Overnite Transportation, the only completely non-union LTL carrier in the study, the unionization rate is set equal to zero, to reflect the fact that all its drivers are non-union.

UNIOND is a dummy variable equal to one if the firm's average unionization rate is above 25 percent, 0 otherwise. This division is made at a clear break point in the data. Five firms are nonunion by this definition.

Prosale is the proportion of total revenues accounted for by motor carrier revenues.

LOSS is the predicted loss in firm value, based on the market value of the firm at December 31, 1977 and the estimates reported in appendix C of chapter II. This variable is scaled in millions of dollars.

L/MCSales is the firm average of the number of employees divided by

motor carrier sales, scaled in number of employees per $10,000 sales. The average L/MCSales was thought to capture better the long-run or steady-state nature of the relation implied by using market value rather than annual profitability as the dependent variable, as it smoothed the effects of cyclical fluctuations.

MCSales are intercity motor carrier revenues, in millions of dollars.

LTLPER is the proportion of total intercity freight revenues accounted for by less-than-truckload freight.

TONMILE is the total ton-miles of intercity freight, in billions of ton-miles.

AVLOAD is the average size of load carried, scaled to hundred ton units.

LTLDUM is a dummy variable equal to one if the firm is a general freight carrier (or owns a general freight subsidiary), 0 otherwise.

The means and standard deviations of the variables used in the empirical analysis are reported in Table 2.

TABLE 2

Data Description

Variable	Sample Mean 1973-82	Standard Deviation
EMVS	.051	.233
u	.735	.349
UNIOND	.754	.432
Prosale	.782	.285
L/MCSales (x 10^{-4})	.023	.008
LOSS	25.142	50.737
LOSS/MCSales	.086	.107
LTLPER	.413	.304
TONMILE (x 10^{9})	.201	.188
AVLOAD (x 10^{2})	.135	.025
LTLDUM	.680	.468

21 Firms:
- 16 general freight (Less-than-truckload) carriers
- 5 specialized commodity (truckload) carriers
- 11 conglomerates

III. Results

This section presents results for several variants of the equations derived in Section I. Although the parameters are identified primarily by cross-firm variation, data on firm value and operating characteristics are available from 1973 through 1982 for most of the firms in the sample.[16] These multiple observations on each firm add information to the cross-sectional data; I consider two approaches to incorporating this information. The first is to estimate the models over five sample periods: 1973, 1974-75, 1976-77, 1978-79, and 1980-82. These divisions correspond to periods for which operating characteristics data are held constant (as a result of data collection techniques; see the data appendix for details).

The second approach is to pool observations across time periods. Because the 1978-79 and 1980-82 results typically differ quite substantially from those for the earlier periods, I estimate the pooled model only over the "regulatory" period, 1973 through 1977. This sample may provide the cleanest test of rent-sharing under regulation, because the regulatory environment in which the union and carriers interacted was stable prior to and during this period. Deregulation of the trucking industry beginning in 1978-79 may have disrupted the historical patterns of union-firm relations, as it reduced the market power and available rents of regulated trucking firms, expanded entry opportunities for and competition from nonunion carriers, and shifted potential competition from service

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[16]Data are unavailable for some firms over the full period, primarily due to divestiture or discontinuance of trucking operations. The full sample size is therefore 203 observations, rather than 210 (21 firms x 10 years).

quality to prices.

This section is structured as follows: Part A discusses results from the constant profit share model. The equations implied by this model are nonlinear in the union's share of rents, λ, and are estimated using the LOSS specification of profitability. Part B presents results from the constant wage premium model. These equations are linear in the parameters. Results are presented for both profit specifications.

A. Constant Profit Share: Nonlinear Models

Results for the constant profit share model are presented in tables 3 and 4. All equations use the LOSS specification of profitability, as equations based on the $X\Phi$ parameterization of profits typically failed to converge and were quite poorly behaved.[17] As described in Section I, I use instruments for LOSS in the estimation, and therefore estimate the equations by nonlinear two-stage least squares. Individual time period results are reported in Table 3. Table 4 reports results for the pooled regulatory period, 1973-1977.

For the pooled system, the scale parameter on LOSS (β) is allowed to vary through time, allowing for changes in profitability over the period. Column 1 of table 4 presents results for the 1973-1977 system based on the model reported in table 3. Column 2 explores the robustness of these results to possible measurement error in unionization rates.

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[17]Iterating over equations with this profit specification often sent one or more parameters to plus or minus infinity.

Table 3

Constant Profit Share Equations

$$EMVS = \alpha 0 \cdot Prosale + \alpha 1 \cdot (1-Prosale) + Prosale \cdot (1-\lambda u) \cdot (\beta \cdot \frac{LOSS}{MCSale} + \theta \cdot LTLDUM)$$

Parameter	1973	1974-75	1976-77	1978-79	1980-82
$\alpha 0$	-.163	-.110	-.143	.090	-.014
	(.124)	(.060)	(.061)	(.055)	(.023)
$\alpha 1$	-.118	-.281	-.074	.031	.057
	(.069)	(.038)	(.051)	(.016)	(.025)
β	6.953	3.612	8.668	.218	-2.579
	(4.25)	(2.08)	(4.06)	(.745)	(3.31)
λ	.692	.436	.754	.308	1.253
	(.152)	(.301)	(.106)	(.196)	(.262)
θ	.143	.069	.137	-.206	.232
	(.339)	(.132)	(.257)	(.050)	(.149)
E'HH'E	.043	.206	.033	.129	.095
SSR	.719	1.218	1.483	.447	.843
No. of Obs	20	42	42	42	56

Equations are estimated by nonlinear two-stage least squares. Asymptotic White heteroskedastic-consistent standard errors in parentheses. E'HH'E is the value of the objective function minimized under non-linear two-stage least squares.

Table 4

Constant Profit Share Equations: Pooled Sample

1973-77

$$EMVS = \alpha 0 \cdot Prosale + \alpha 1 \cdot (1-Prosale) + Prosale \cdot (1-\lambda u) \cdot \left(\beta \cdot \frac{LOSS}{MCSale} + \theta \cdot LTLDUM\right)$$

Parameter	u as instrument for u	UNIOND as instrument for u
$\alpha 0$	-.150	-.168
	(.047)	(.051)
$\alpha 1$	-.171	-.177
	(.029)	(.033)
β	7.255	8.413
	(2.238)	(2.766)
λ	.694	.742
	(.083)	(.073)
θ	.123	.211
	(.148)	(.194)
$\beta 74\text{-}5$	-1.155	-1.431
	(1.433)	(1.772)
$\beta 76\text{-}7$	1.106	1.210
	(1.011)	(1.224)
E'HH'E	.024	.113
SSR	3.911	4.536
Instrument for u	u	UNIOND
No. of Obs	104	104

Equations estimated by nonlinear two-stage least squares. Asymptotic White heteroskedastic-consistent standard errors in parentheses. E'HH'E is the value of the objective function minimized under non-linear two-stage least squares.

Measurement error in observed unionization rates could arise from two sources. First, the assumption that owner-operators are nonunion drivers paid competitive wages may be incorrect. When owner-operators are employed by large firms that are almost completely unionized, the Teamsters may be effective in ensuring that the owner-operators are paid union wages. The second source of error is the possibility that what matters from the standpoint of firm value is some equilibrium or "average" unionization rate, not fluctuations in unionization rates over the business cycle. Either of these sources of error is likely to bias estimated union premiums toward zero. To adjust for the possibility of measurement error, I use as an instrument for the unionization rate a dummy variable, UNIOND, equal to zero if the firm's average unionization rate is 25 percent or less, and one otherwise. This is a natural break point in the data; firms are clustered at zero to 25 percent unionized and at 85 to 100 percent unionized, with only two firms in between, at 70 percent. Five firms are "nonunion" firms by this criterion.

The first and most striking feature of the results in tables 3 and 4 is the tight clustering of the estimated union share of rents over the regulated years, 1973 through 1977. The union share of profits, λ, is estimated at 70 to 75 percent in the 1973 and 1976-77 individual equations, as well as in both pooled equations. In 1974-75, the point estimate is within one standard deviation of this range. The estimates in the pooled systems are fairly precise, with asymptotic standard errors on the order of 8 percentage points. Column 2 of table 4, which uses UNIOND as an instrument for the unionization rate, yields a slightly larger estimated

union share, but the point estimate is within one standard deviation of that in column 1.

These results provide quite strong support for the view that the Teamsters capture a significant fraction of regulatory rents, and further suggest that the union is the dominant "winner" from regulation. If the Teamsters obtain 70 percent of total rents in a completely unionized firm, then labor's "profits" from regulation are more than twice those retained by the company. This supports the hypotheses of Annable (1973) and Moore (1978), which posit that the union captured more than half of the rents available from motor carrier regulation. It is also consistent with Salinger's (1984) estimate of the average share of rents captured by unions in his cross-industry study of a sample of manufacturing firms. Salinger uses Tobin's q as the dependent variable to estimate a mean union share of 77 percent, based on industry average unionization rates for his sample of companies.[18]

The second general feature of these results is that the scale parameters (β) on LOSS tend to be quite large. Estimates of β average 7 to 8, over the regulatory period, implying that total rents are much greater than estimated in my earlier work (Rose, 1984). In the pooled equations, β is permitted to vary through time. A common β is estimated for all years; β74-5 and β76-7 are incremental effects for the corresponding time periods. These coefficients suggest a decline in β during the 1975 recession, and a slight increase (relative to 1973) for 1976-77, although

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[18]Salinger's coefficient estimate for λ is about 1.7, but his sample mean unionization rate is .45. He argues that only 10 percent of his firms have unionization rates large enough to drive $1-\lambda u$ negative.

both β74-5 and β76-7 are within one asymptotic standard error from zero.

Evaluating predicted profit rates at the sample means for the regulatory period suggests that rents accruing to completely unionized trucking firms were roughly two-and-a-half times measured LOSS, and that rents captured by the Teamsters were twice the firms' profits. Translating the union's gain into rents per unionized worker implies that the Teamsters reduced firm's profits by about $28,000 per worker in present discounted value. Because payments to labor are deductible from corporate income taxes, profits are reduced by only $(1-\tau)$ for each dollar paid to workers, where τ is the corporate income tax rate.[19] This implies that workers received roughly $56,000 in present discounted value rents. Assuming a discount rate of about 10 percent, these are equivalent to $5,600 of annual rents per union worker.[20]

The equations for the deregulation years, 1978 through 1982, appear to be less well-specified. In 1978-79, both union share and total rents appear to be quite small, with λ estimated at .31 (standard error, .20) and β at .22 (.75). In 1980-82, λ is estimated as greater than one--implying that the union took more than all the rents. Concomitant with this is a negative point estimate of β. Neither of these results seem sensible; they may indicate instability in the relationship after deregulation.

The less-than-truckload fixed effect, θ, is estimated with the

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[19] I am grateful to Larry Summers for pointing this out.

[20] These are based on the results in column 1, evaluated at the pooled sample means of the variables.

expected positive sign in all but the 1978-79 equation, although the (asymptotic) standard errors are quite large. The estimated intercepts ($\alpha 0$ and $\alpha 1$) are similarly imprecise in the individual equations. The constants in the pooled equations suggest that motor carrier and other operations have similar valuation rates in the absence of excess returns to trucking operations (i.e., $\Pi = 0$). However, values below 0 imply market values less than replacement cost, contradicting the notion that replacement cost should provide a "floor" on market value for a growing industry. While the estimated intercepts violate these "floors," the results are similar to those obtained by studies using Tobin's q. Taxes may be a possible rationale for this phenomenon; see Salinger and Summers (1983) and note 7 supra.

B. Constant Wage Premium: Linear Models

Results for constant wage premium specifications over individual time periods are presented in table 5 for the LOSS specification of profits, and in table 6 for the $X\Phi$ specification. These equations are linear in the parameters, and therefore are estimated by ordinary least squares for those using the $X\Phi$ specification of profitability and by two stage least squares for those involving the LOSS specification.[21] The coefficient estimates for the regulatory years are clustered quite closely in the LOSS equations in table 5. This is similar to the pattern for the nonlinear models discussed above. This feature is not evident in the $X\Phi$ specifications in table 5,

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[21]The point estimates for γ in the LOSS equations are somewhat sensitive to the choice of instruments, although the point estimates typically are within one standard deviation of each other.

Table 5

Constant Wage Premium Equations

LOSS Specification of Profitability

$$EMVS = \alpha 0 \cdot Prosale + \alpha 1 \cdot (1-Prosale) + Prosale \cdot (\beta \cdot LOSS/MCSales - \gamma \cdot u \cdot Labor/MCSales + \theta \cdot LTLDUM)$$

Parameter	1973	1974-75	1976-77	1978-79	1980-82
$\alpha 0$	.004	-.030	.006	.076	.035
	(.073)	(.068)	(.052)	(.050)	(.034)
$\alpha 1$	-.050	-.263	-.023	.037	.023
	(.037)	(.026)	(.030)	(.016)	(.024)
β	1.850	2.177	2.095	-.017	.979
	(.564)	(.418)	(.586)	(.594)	(.814)
γ	.881	.837	.967	-.453	1.015
	(.757)	(.625)	(.514)	(.256)	(.429)
θ	.187	.154	.155	-.231	.130
	(.171)	(.142)	(.119)	(.067)	(.080)
SSR	.558	1.113	1.044	.470	.784
Estimation	2SLS	2SLS	2SLS	2SLS	2SLS
No. of Obs.	20	42	42	42	42

Asymptotic White heteroskedastic-consistent standard errors in parentheses.

Table 6

Constant Wage Premium Equations

XΦ Profit Specification

$$EMVS = \alpha 0 \cdot Prosale + \alpha 1 \cdot (1-Prosale) + Prosale \cdot (\phi 1 \cdot LTLPER + \phi 2 \cdot TONMILE + \phi 3 \cdot AVLOAD - \gamma \cdot u \cdot Labor/MCSales + \theta \cdot LTLDUM)$$

Parameter	1973	1974-75	1976-77	1978-79	1980-82
$\alpha 0$	-.118	-.117	.131	-.145	-.142
	(.162)	(.175)	(.079)	(.109)	(.123)
$\alpha 1$	-.152	-.142	.096	.117	.077
	(.064)	(.064)	(.072)	(.054)	(.052)
$\phi 1$	.446	-.001	.539	.871	-.018
	(.116)	(.320)	(.262)	(.200)	(.103)
$\phi 2$	-.552	.285	-.204	-.839	-.161
	(.330)	(.302)	(.230)	(.241)	(.182)
$\phi 3$	1.600	.765	-.922	2.224	1.355
	(1.441)	(1.594)	(.616)	(.983)	(.894)
γ	.481	.355	.083	.111	.869
	(.205)	(.292)	(.192)	(.139)	(.255)
θ	-.212	.057	-.302	-.581	.146
	(.069)	(.202)	(.174)	(.103)	(.076)
SSR	.062	.667	.750	.237	.538
Estimation	OLS	OLS	OLS	OLS	OLS
No. of Obs.	20	42	42	42	56

All equations are estimated with fixed effects for three companies: Preston Trucking, Roadway Express, and Yellow Freight. White heteroskedastic-consistent standard errors in parentheses.

where the coefficients tend to move about without any clear pattern. In general, the point estimates in all the individual time period equations are fairly imprecise. Because of this, I defer discussion of particular results to the pooled sample equations.

Table 7 reports the results for equations pooling the regulatory years, 1973-77. Column 1 presents estimates for the LOSS specification using u as an instrument for itself. Column 2 presents results for this equation using UNIOND as an instrument for the unionization rate, following the rationale discussed earlier. Estimates for the comparable equations using the $X\Phi$ specification of profits are reported in columns 3 and 4. For all equations, the intercept for motor carrier operations is allowed to vary over time, to reflect possible changes in profitability levels. These results are discussed in some detail below.

The first thing to note about table 7 is that γ, the estimated union rents per worker, is correctly signed in all equations and is more than two (aymptotic) standard deviations from zero for three of the four equations (all but column 3). However, the magnitude of the coefficient is substantially lower than would be comparable to the nonlinear results. γ is measured in units of $10,000 of reduced profits, in present discounted value, per unionized worker. If one assumes a discount rate of roughly 10 percent and a corporate income tax rate of .50, the reported coefficients can be interpreted as 2γ thousand dollars per unionized worker per year in union rents.

Given this scaling, the point estimates imply much lower union rents than do the previous results. The LOSS equations in columns 1 and 2

Table 7

Constant Wage Premium Equations

Pooled Sample: 1973-77

$$EMVS = \alpha 0 \cdot Prosale + \alpha 1 \cdot (1-Prosale) + Prosale \cdot (\tilde{\pi} - \gamma \cdot u \cdot Labor/MCSales + \theta \cdot LTLDUM) + \sum \alpha_t \cdot DUM_t \cdot Prosale$$

	$\tilde{\pi}=\beta \cdot LOSS/MCSale$		$\tilde{\pi} = \phi 1 \cdot LTLPER + \phi 2 \cdot TONMILE + \phi 3 \cdot AVLOAD$	
Parameter	(1)	(2)	(3)	(4)
$\alpha 0$	.009 (.061)	.034 (.065)	.127 (.082)	.108 (.084)
$\alpha 1$	-.117 (.014)	-.112 (.014)	.011 (.050)	.014 (.020)
β	2.156 (.302)	2.124 (.306)		
$\phi 1$			.057 (.192)	.056 (.193)
$\phi 2$			.066 (.210)	.052 (.212)
$\phi 3$			-.366 (.690)	-.146 (.706)
γ	.922 (.352)	1.251 (.402)	.242 (.170)	.360 (.178)
θ	.157 (.083)	.219 (.092)	.020 (.123)	.038 (.124)
$\alpha 74\text{-}75$	-.060 (.063)	-.063 (.065)	-.097 (.049)	-.097 (.049)
$\alpha 76\text{-}77$	.009 (.049)	.006 (.051)	-.105 (.051)	-.105 (.051)
DPTRK			.419 (.116)	.427 (.116)
DROAD			.918 (.156)	.923 (.156)
DYELL			.665 (.115)	.664 (.116)
SSR	2.886	3.058	2.171	2.176
Estimation	2SLS	2SLS	OLS	2SLS
No. of Obs.	104	104	104	104
Instrument for u	u	UNIOND	u	UNIOND

Asymptotic White heteroskedastic-consistent standard errors in parentheses.

suggest that the Teamsters capture annual rents in the range of $2000 to $2500 per worker. These estimates are only 35 to 45 percent of the gains estimated in the nonlinear equations, and 25 to 35 percent of the union premiums suggested by wage data.[22] The premia implied by the coefficients in columns 3 and 4 are even smaller--on the order of $500 to $700 per year. However, these latter estimates may be affected by the generally poor performance of the XΦ profit specification, as discussed below.

Concomitant with this result is a low estimate of total rents in the linear models. Implied total rents based on the linear LOSS equations are much lower than are those in the nonlinear models. The parameter on LOSS in both sample periods is near two, as compared to seven or eight in the nonlinear results. This corresponds to total rents that are about 40 to 50 percent of those estimated in the tables 3 and 4. Based on the estimates in column 1 of table 7, firm rents for an all-union company are about one-and-a-half times LOSS; the union reduces the firm's total rents by about 250 percent of LOSS, evaluating the expressions at sample means. Notably, these results still imply that the union takes a major share of the profits--equal to 63 percent for this set of calculations. However, even if the Teamsters captured all the implied rents, the average present discounted value of profits received by each worker would be only $40,000.

Unfortunately, the data do not point to a clear choice between the two functional forms of the union's rent share. If the constant profit share model is correct, the parameters in the linear model will be biased toward

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22Wage studies typically estimate union wage premia of 50 percent over nonunion wages during the regulatory period. Applying this wage differential to average annual compensation (including fringes, pensions, and other employer contributions) for drivers of Class I general freight common carriers in 1977 implies a premium in the range

zero, given the sample correlation between the profitability rate and the labor/sales ratio. This is consistent with what we observe. However, if the constant wage premium model is correct, the parameters in the nonlinear model will be biased away from zero; also consistent with observed relations between the two sets of results. It seems sensible to consider the two contract forms as bounding the range of union rents.

The XΦ parameterization of profits, reported in columns 3 and 4, appears to be poorly specified, as alluded to earlier. TONMILE has the incorrect sign in both equations, although the asymptotic standard errors are much larger than the coefficient estimates. The coefficients of the other operating characteristics have the expected sign, but similarly enormous standard errors. The imprecision of the estimates in these equations makes it difficult to draw any firm conclusions from the results.

The remaining parameters in the four equations are basically as anticipated. The LTL fixed effect is positive, and roughly twice the size of its standard error in the LOSS equations. Non-trucking operations have intercepts significantly below zero for the LOSS equations, and indistinguishable from zero in the column 3 and 4 results. The intercepts for trucking operations appear to decline over the sample period in all

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of $8500 per year. This is calculated from total compensation divided by total average number of employee drivers (paid on either a mileage basis or other basis), as reported in the ICC's TRANSPORT STATISTICS IN THE U.S., MOTOR CARRIERS, PART 2, 1977. It assumes that 80 percent of these drivers are union members, and implies average nonunion compensation of $17,000. Using average nonunion wages of $11,000 per year for a sample of truck drivers in the 1977 Current Population Survey implies a union premium of $5500 per year.

four equations, although the coefficients are significant (evaluated at asymptotic standard errors) only in columns 3 and 4.

Looking at the results using UNIOND as an instrument for the unionization rate, columns 2 and 4, the only coefficient that is appreciably affected is γ. The point estimate of γ increases by about 30 percent--from .92 to 1.25 for the equation using LOSS to measure profits, and from .24 to .36 for the $X\Phi$ equation. The asymptotic standard errors are relatively unaffected by this procedure. The remaining coefficients are nearly identical to those estimated with u as an instrument for itself. These results suggest that errors in variables in unionization rates may dampen the estimated coefficients toward zero, although the wage premiums remain below those derived from the nonlinear results and union wage data.

Conclusions

This paper studies the division of rents between the Teamsters Union and owners of regulated trucking firms by examining crosssectional variations in excess market value-to-sales ratios. It provides new estimates of both the total magnitude of rents in the motor carrier industry, and the allocation of these rents between the various factors of production. The results reinforce Salinger's (1984) finding of a 77 percent union profit share for a sample of large manufacturing firms. My estimates from a specification similar to his, which assumes that the union takes a fixed share of firm profits, suggest that the Teamsters receive between 60 and 75 percent of trucking industry rents.

The results stand in contrast to those for studies of union wage differentials in the trucking industry. This methodology yields somewhat lower reductions in profits for unionized firms than is implied by estimated union wage premia. This apparent difference might be explained in several ways. One possibility is that unionized workers are higher quality or more productive than their nonunion counterparts, so that the wage differential between the two groups does not accurately measure the firm's cost from unionization. Anecdotal evidence suggests that Teamsters may be more reliable, and engage in less pilferage, than their nonunion counterparts. It also is possible that operating ratio regulation enables firms to recoup some of the costs of higher union wage settlements. This implies that total rents in the trucking industry may not be fixed, and

that some of the union wage gains are shifted forward to trucking consumers as increased prices. These remain topics for future research.

DATA APPENDIX

The data set used in this study consists of observations on 21 trucking companies over the period 1973 through 1982. Earlier observations are used to construct market value and replacement cost variables, based on COMPUSTAT data from 1965 through 1983. Because the first year of data availability is not 1965 for all companies, market value and replacement cost estimates are based on longer pre-sample series for companies included from 1965 on than for those which are first observed later than 1965. EMVS is constructed only for the 1973-1982 period.

The variables used in the analysis and their derivations are described below. The calculation of market value and replacement cost series generally follows the procedures of previous studies that have used q; see, for example, Brainard, Shoven, and Weiss (1980), Lindenberg and Ross (1981), and Salinger and Summers (1983). Because these calculations are not standardized across authors, and do involve a number of assumptions and simplifications, they are discussed in some detail. The primary data sources are: Standard & Poor's COMPUSTAT data base, TRINC'S Blue Book of the Trucking Industry, and companies' annual 10K filings with the SEC.

1. Market Value

The market value of the firm is calculated as the sum of the values of four types of claims on the firm: common equity, preferred equity, long-term debt, and short-term debt. Ideally, value would be measured as the price of each type of claim times the number of units of that claim

outstanding. Unfortunately, price data is readily available only for common equity of these firms. Consequently, the value of the remaining claims is approximated as discussed below.

Common Equity: The market value of common equity, MVE, is computed as the year-end closing price times the number of shares outstanding, as reported by COMPUSTAT.

Preferred Equity: The value of preferred equity, MVP, is calculated as the total amount of preferred dividends paid (reported by COMPUSTAT) divided by the Standard & Poor's preferred stock yield index.

Short-term Debt: Because this is a short-term claim, the market value of short-term debt, MVSTD, is assumed to equal its book value, as reported by COMPUSTAT.

Long-term Debt: The procedure used to compute the market value of long-term debt, MVLTD, follows Salinger and Summers (1983). The discussion below is based on their data appendix.

To estimate the maturity structure of a firm's debt, the following assumptions are made:

(1) All new issues of long-term debt have a 20-year maturity.

(2) If T_d is the first year that COMPUSTAT reports data on the long-term debt of the firm, then the maturity distribution of debt in year T_d is proportional to the aggregate new issues of corporate debt for the preceeding twenty years, as reported in the Statistical Supplement to the Survey of Current Business (1969 and 1979), Tables of New Securities Issued--Corporate Bonds.

(3) Each year, the debt issued twenty years earlier is retired. The firm may choose to issue new debt, or to retire additional outstanding debt. If the firm chooses the latter, it is assumed that issues from all previous years are reduced proportionally.

These imply that new issues for years T_d to 1982 are:

$$N_t = \begin{cases} LTD_t - LDT_{t-1} + N^*_{t-20,t-1} & \text{if } LTD_t - LTD_{t-1} + N^*_{t-20,t-1} > 0 \\ 0 & \text{otherwise} \end{cases}$$

and

$$N^*_{i,t} = \begin{cases} N^*_{i,t-1} & \text{if } LTD_t - LTD_{t-1} + N^*_{t-20,t-1} > 0 \\ N^*_{i,t-1} \cdot \dfrac{LTD_t}{LTD_{t-1} - N^*_{t-20,t-1}} & \text{otherwise} \end{cases}$$

where N_t is new issues of long-term debt in year t

LTD_t is the amount of long-term debt outstanding in year t

$N^*_{i,t}$ is the amount of long-term debt issued in year i that is outstanding in year t.

To calculate the market value of debt at t, given the maturity distribution, we assume that the coupon rate is the average BAA rate in the year of issue, and that the debt maintains a BAA rating through maturity. This permits the market value of each debt issue to be calculated by the coupon bond formula:

$$MV(N^*_{i,t}) = N^*_{i,t} \cdot \frac{BAA_i}{BAA_t} \left[1 - \left(1/(1+BAA_t)\right)^{i+20-t} \right] + \left(1/(1+BAA_t)\right)^{i+20-t}$$

The market value of all outstanding long-term debt is calculated as the sum of the market values at time t of each outstanding issue:

$$MVLTD_t = \sum_{i=t-19}^{t} MV(N^*_{i,t})$$

The total value of the firm at time t is given by:

$$MV_t = MVE_t + MVP_t + MVSTD_t + MVLTD_t$$

2. Replacement Cost

The replacement cost of the firm is based on three types of assets: (1) property, plant, and equipment, (2) inventories, and (3) cash and short-term assets. Note that this excludes intangible assets such as the value of ICC operating authorities. It is precisely these assests whose value we wish to measure. If we included them in the calculation of replacement cost (ignoring for a moment the difficulty of directly valuing them), EMVS would equal 0 for all firms, and we would be unable to measure variances in profitability across firms. The calculation of replacement cost follows the general procedures used in other q studies. Because of the importance of these calculations in the data, I outline the method employed in some detail.

Property, Plant, and Equipment: Determining the replacement cost of a firm's property, plant, and equipment (PPE) is extremely difficult, given limitations on the data reported in companies annual reports or SEC 10K filings. Accounting data on net PPE is based on historical acquisition costs and artificial book depreciation rates. They consequently are likely to bear little relation to economic replacement costs. Further, although the SEC began to require some companies to report inflation adjustments and "replacement costs" on their 10K filings beginning in 1976, these are

generally unavailable for firms in my sample. Despite subsequent extension of these accounting requirements to a larger universe of firms, only 13 of the 21 firms in my sample report any replacement cost information between 1977 and 1983. Therefore, a method of computing replacement costs must be developed.

Previous authors confronted by this problem have adopted a variety of closely related solutions. Lindenberg and Ross(1981) compute replacement cost of plant and equipment as a function of capital price changes, estimated rates of technical progress and economic depreciation, and reported capital investments by the firm. They assume that the book value of plant and equipment equals the replacement value for 1952, the first year of their sample. This value is escalated based on the four factors mentioned above. Salinger and Summers (1983) begin by constructing an artificial investment series for each firm prior to 1960, the first year of their sample. They assume investment is proportional to aggregate investment and consistent with the firm's book value of gross plant and equipment in 1960. Replacement costs are built from the investment series (artificial prior to 1960 and reported from 1960 to 1978), the consumer price index, and a calculated rate of economic depreciation.

Brainard, Shoven, and Weiss (1980), hereafter BSW, adopt a somewhat more complicated procedure. These authors differentiate between plant and equipment, assuming the the fraction of gross investment in equipment is constant at the calculated 1975 share. They construct an artificial investment series prior to 1958 (their first sample year) by assuming that the ratio of the firm's investment to aggregate investment changed a

constant rate θ over the period and requiring gross investment to be consistent with 1958 reported gross plant and equipment. Replacement cost is computed from the artificial and real investment series, a rate of economic depreciation, price level changes, and adjustments for estimated retirements and "write-offs" of capital stocks (which include sales of plant and equipment). BSW define write-offs, WO, as the change in gross plant plus investment minus estimated retirements. They scale their estimate of replacement cost for a given year by writing off a portion of the capital stock, based on that year's value for WO.

This last feature--correcting for estimated "write-offs" of capital--most distinguishes the BSW approach from the others. The other authors apparently rely only on reported capital expenditures by the firm to increment the capital stock. Gross and new plant figures are disregarded. Salinger and Summers argue: "In general, there are serious problems with using property, plant, and equipment figures reported by companies. For example, one can go far awry by estimating gross plant in year t by adding gross plant in year t-1 to investment in year t and subtracting estimated retirements. . . Depreciation method changes and mergers are the most common causes for the estimates to fail." (p. 279).

However, the times when gross plant in year t deviates from gross plant at t-1 plus investment less retirements at t are precisely the times when incrementing by investment without accounting for write-offs (which is the amount of this deviation) will misrepresent the firm's true capital stock. Sales of property, plant and equipment, divestitures of subsidiaries or portions of the firm's business, and certain types of

mergers will not be detected by the capital expenditures series, although they will appear in the plant and WO series. Failing to account for these may yield replacement costs that trend slowly upward even when the real capital stock of the firm has sharply increased or decreased. Further, this error generally will persist and may be substantial. For example, in my sample of 21 trucking firms, only 3 report no expenditures on acquisitions over the entire sample period; only 5 fail to record sales of property, plant, and equipment during the sample period. Many of the largest mergers were accomplished through exchange of shares of common stock, and consequently were not reported as investments or acquisitions; several involved doubling or tripling net plant. In addition, a number of companies spun off subsidiaries, often reducing net and gross plant by 30 to 40 percent.

Given this, it seems essential to account for changes in reported property, plant, and equipment in determining replacement costs. I therefore calculate replacement costs as follows: I first estimate the average life of the firm's investments, as $L = \sum_{t=1965}^{1982} (GPP_{t-1} + I_t)/Dept$, where Dep is the depreciation claimed by the firm. I then construct an artificial series of investment (I) for the L years prior to COMPUSTAT's first year of reported capital expenditures for the firm (this year is denoted T_i). Investment in these pre-sample years is assumed to be proportional to private nonresidential fixed investment, consistent with gross plant at year T_i. For subsequent years, investment is taken to be capital expenditures as reported by COMPUSTAT (item 30). The implicit

price deflator for gross fixed private non-residential investment is used to measure capital goods price changes. Depreciation is assumed to be exponential at the rate 2/L. Write-offs, WO, are calculated as $WO_t = (GPP_{t-1} - GPP_t) + I_t$ for years beginning with T_i, and are assumed to be zero for the pre-sample years. These are assumed to be proportional to the firm's existing capital stock. The replacement cost of property, plant, and equipment, RPP, is given by the function:

$$RPP_t = \left[RPP_{t-1} \cdot \frac{P_t}{P_{t-1}} \cdot (1 - WO_t/GPP_{t-1}) + I_t \right] \cdot (1 - 2/L)$$

Replacement costs for the early years of this calculation are based almost entirely on the artificial investment series; as more years of actual investment data enter the calculation, the measures become more meaningful.

Inventories: Although calculation of replacement cost of inventories is an important concern for studies of manufacturing companies, it is less significant for the current study. Inventories are not substantial for most trucking firms; in fact, a number of sample firms report no inventory holdings at all. Those that do report inventories typically record quite low values for their holdings; the inventories appear to consist largely of materials such as replacement tires. Several of the conglomerates are the exceptions; these often have manufacturing subsidiaries, and the consolidated statement indicates sizable inventory holdings.

Most sample companies use FIFO (first-in, first-out) or some other type of replacement cost accounting for their inventories. For these companies, the reported book value of inventories should closely track

their replacement cost. However, four firms report using LIFO (last-in, first-out) accounting from part or all of their inventories as of 1978, the benchmark year (and mid-point of the sample). For these firms, reported inventory values will tend to understate replacement cost.

The procedure used to adjust inventories follows Salinger and Summers (1983). I assume that all inventory accounting methods except LIFO--average cost, standard cost, replacement cost, and FIFO-- are equivalent to FIFO. For these firms, replacement cost of inventories is assumed to equal reported inventories. Two firms report using both LIFO and a FIFO method. I assume that the first method (which is the more important) is used for two-thirds of the real inventories and the second is used for the remaining one-third. Finally, I assume the inventory accounting method reported in 1978 was used throughout the sample period. For firms not reporting the inventory valuation method in 1978, I use the method recorded in the year closest to 1978 for which this data was reported. (In general, inventory valuation methods seem fairly stable for these firms, so this is not an unreasonable assumption).

The book value of inventories is assumed to equal the replacement cost regardless of accounting method for the first year in which inventories are reported by COMPUSTAT for the firm (T_n). This will be approximately true if prices are stable during the years prior to T_n. It will be less correct for firms that enter the sample late. For firms using only LIFO, real inventories, RINV, are given by:

$$RINV_t = \begin{cases} RINV_{t-1} \cdot \frac{PIN_t}{PIN_{t-1}} + INV_t - INV_{t-1} & \text{if } INV_t \geq INV_{t-1} \\ RINV_{t-1} \cdot \frac{PIN_t}{PIN_{t-1}} + (INV_t - INV_{t-1}) \cdot \frac{PIN_t}{PIN_{t-1}} & \text{otherwise} \end{cases}$$

where INV are reported inventories from COMPUSTAT and PIN is the implicit price deflator for total business inventories.

For firms using both FIFO and LIFO, inventories are separated into FIFO and LIFO components. Each component is valued as above. However, because inflation will change the relative shares of these components in book inventories (even though the share in real inventories is assumed constant), adjustments to reported inventories become quite complicated. The formulae used to determine real inventories for these firms are detailed in the appendix to Salinger and Summers and will not be reproduced here.

Cash and Short-term Investments: These assets consist of cash and securities that can be readily transferred into cash. Because these are short-term, highly liquid assets, their book value from COMPUSTAT is assumed to equal their replacement cost.

Given this, the replacement cost of capital is given by

$$RC_t = RPP_t + RINV_t + CASH_t$$

and the ratio of excess market value to sales (EMVS) is

$$EMVS_t = (MV_t - RC_t)/SALES_t$$

3. Operating Characteristics

Data on firms' operating characteristics are primarily from TRINC'S Blue Book of the Trucking Industry (TRINC'S), various years. There typically is little time series variation in operating characteristics for single firm; the data are therefore collected biannually. Many firms operate more than one trucking subsidiary. The values of the operating characteristics for these companies are computed as the sums (or, for ratio variables, as the weighted averages) of the reported values for their individual subsidiaries. Due to extensive turn-over in ownership of trucking firms, subsidiaries must be identified for each year that operating data are collected. This is accomplished by referencing Moody's Transportation Manual and Moody's Industrial Manual for the relevant years. TRINC'S is consulted for additional ownership information when necessary. Subsidiaries that are not reported in TRINC'S are assumed to have a negligible influence on firm-wide operating data. The variables are defined as follows:

u (unionization rate): The unionization rate is defined as (1- RENT), where RENT is the proportion of total miles accounted for by miles in vehicles rented with drivers. These typically are vehicles driven by "owner-operators." Because data on the proportion of union drivers was not available, I use this measure to represent the potential share of union labor. For Overnite Transportation, the only non-union LTL carrier in the study, this variable is set equal to zero, to reflect the fact that its drivers are all non-union.

ProSale: The proportion of total revenues accounted for by motor carrier revenues. This is computed biannually. Total sales are gross sales as reported by COMPUSTAT. Motor carrier revenues are total intercity freight revenues, as reported by TRINC'S.

LTLPER: The proportion of total intercity freight revenue accounted for by less-than-truckload operations.

TONMILE: Total ton-miles of freight transported.

AVLOAD: The average size of loads carried, measured in tons.

LOSS: The predicted loss in firm value, based on the market value of the firm at December 31, 1977, and the losses estimated in Rose (1984), Appendix C.

L/MCSales: The firm average over the entire sample period of the number of motor carrier employees divided by intercity freight revenues.

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